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Hatano

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(54) **RECORDING MEDIUM CONVEYANCE APPARATUS, IMAGE FORMING APPARATUS, RECORDING MEDIUM CONVEYANCE METHOD AND RECORDING MEDIUM STORING PROGRAM OF RECORDING MEDIUM CONVEYANCE METHOD**

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B65H 16/00 (2006.01)
B65H 26/06 (2006.01)

(52) **U.S. Cl.**
CPC ***B65H 16/00*** (2013.01); ***B65H 19/00*** (2013.01); ***B65H 26/06*** (2013.01); *B65H 2301/41522* (2013.01); *B65H 2404/143* (2013.01); *B65H 2511/114* (2013.01); *B65H 2553/51* (2013.01); *B65H 2801/36* (2013.01)

(58) **Field of Classification Search**
CPC B65H 19/00; B65H 19/28; B65H 19/29; B65H 19/2261; B65H 19/2207; B65H 23/00; B65H 23/044; B65H 23/004; B65H 23/182; B65H 23/1825
See application file for complete search history.

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(57) **ABSTRACT**

A recording medium conveyance apparatus includes a feeding unit for accommodating a roll pipe and feeding a recording medium, a conveyance unit for conveying the recording medium fed by the feeding unit, and a determination unit for determining an accommodation state of the recording medium accommodated in the feeding unit. The feeding unit includes a driving unit for rotating the roll pipe and a detection unit for detecting a rotational operation of the roll pipe. The conveyance unit, using at least two rollers, conveys or fixes the recording medium by nipping it with the rollers. The determination unit, based on the rotational operation of the roll pipe detected by the detection unit when the recording medium is fixed by the rollers, determines whether the recording medium is fixed to the roll pipe or not.

14 Claims, 6 Drawing Sheets

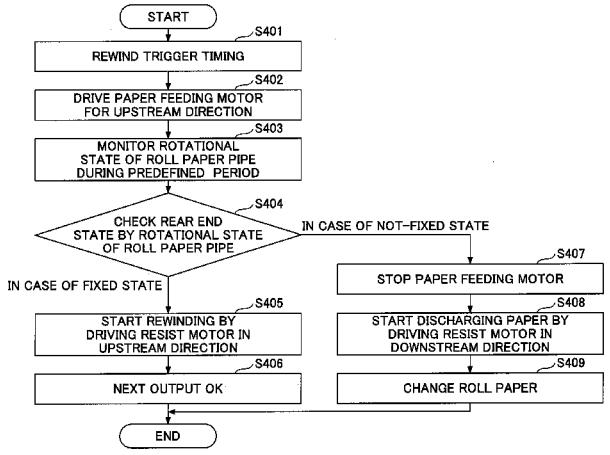


FIG.1

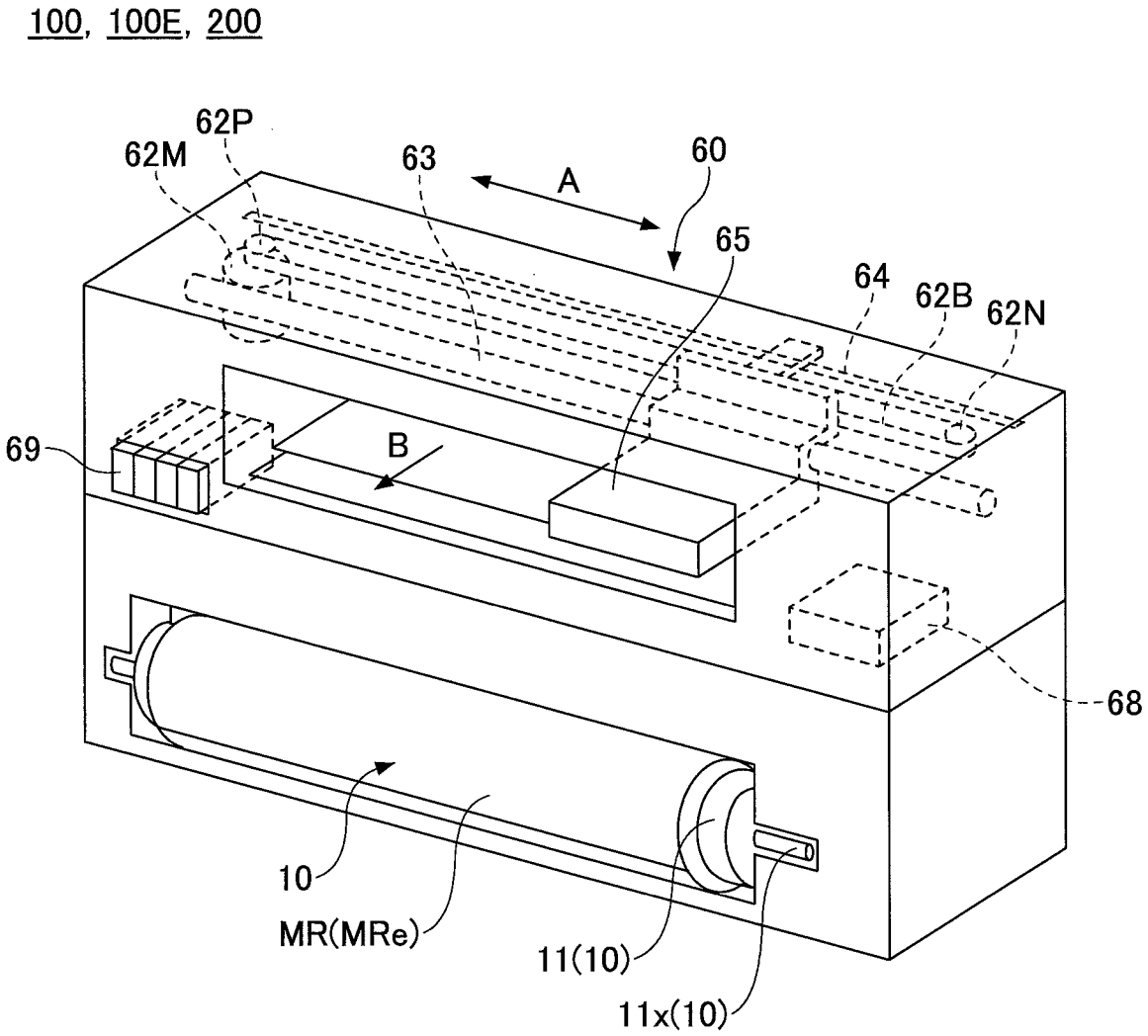

100, 100E, 200
62P
62M
63
A
60
65
64
62B
62N
69
B
68
10
MR(MRe)
11(10)
11x(10)

FIG.2

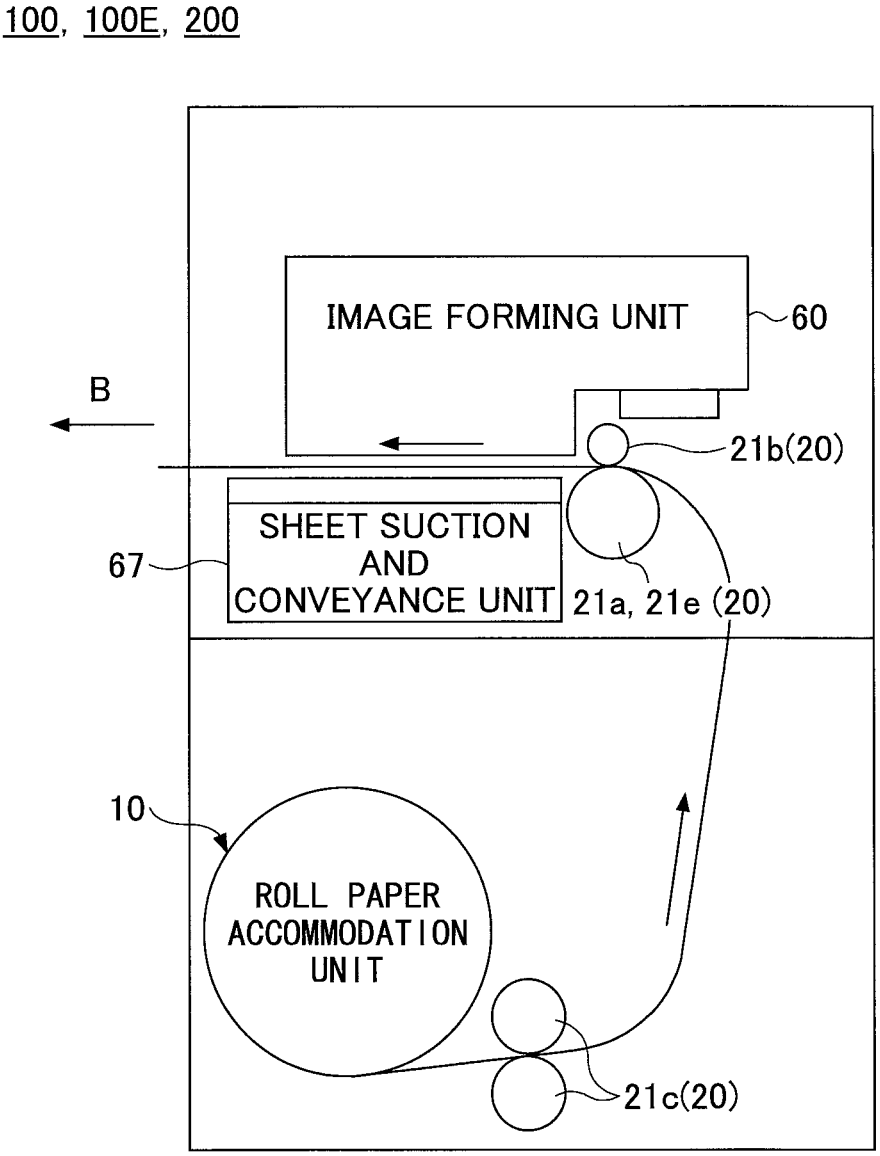

100, 100E, 200
IMAGE FORMING UNIT
60
B
21b(20)
SHEET SUCTION AND CONVEYANCE UNIT
67
21a, 21e (20)
10
ROLL PAPER ACCOMMODATION UNIT
21c(20)

FIG.3

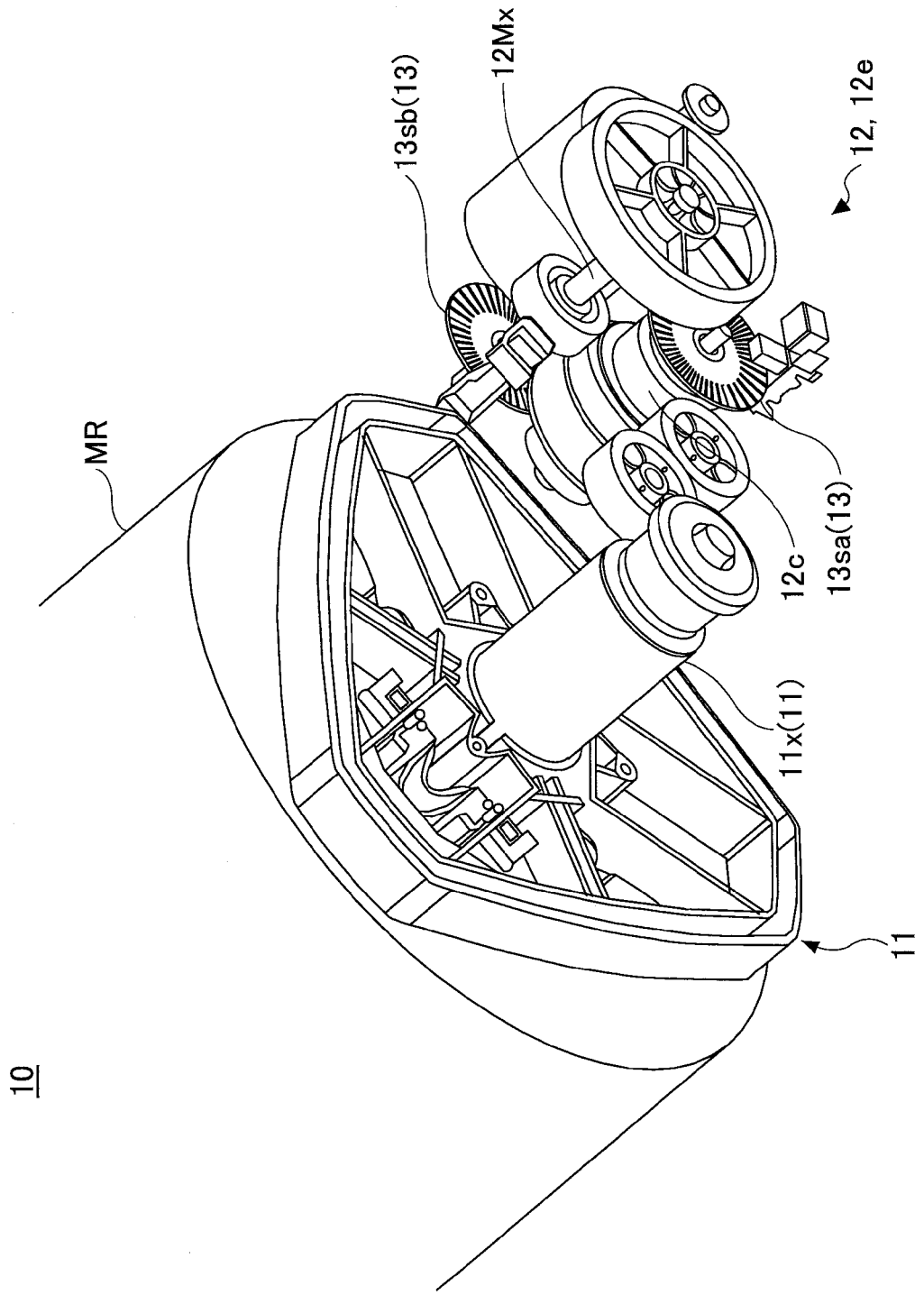


FIG.4

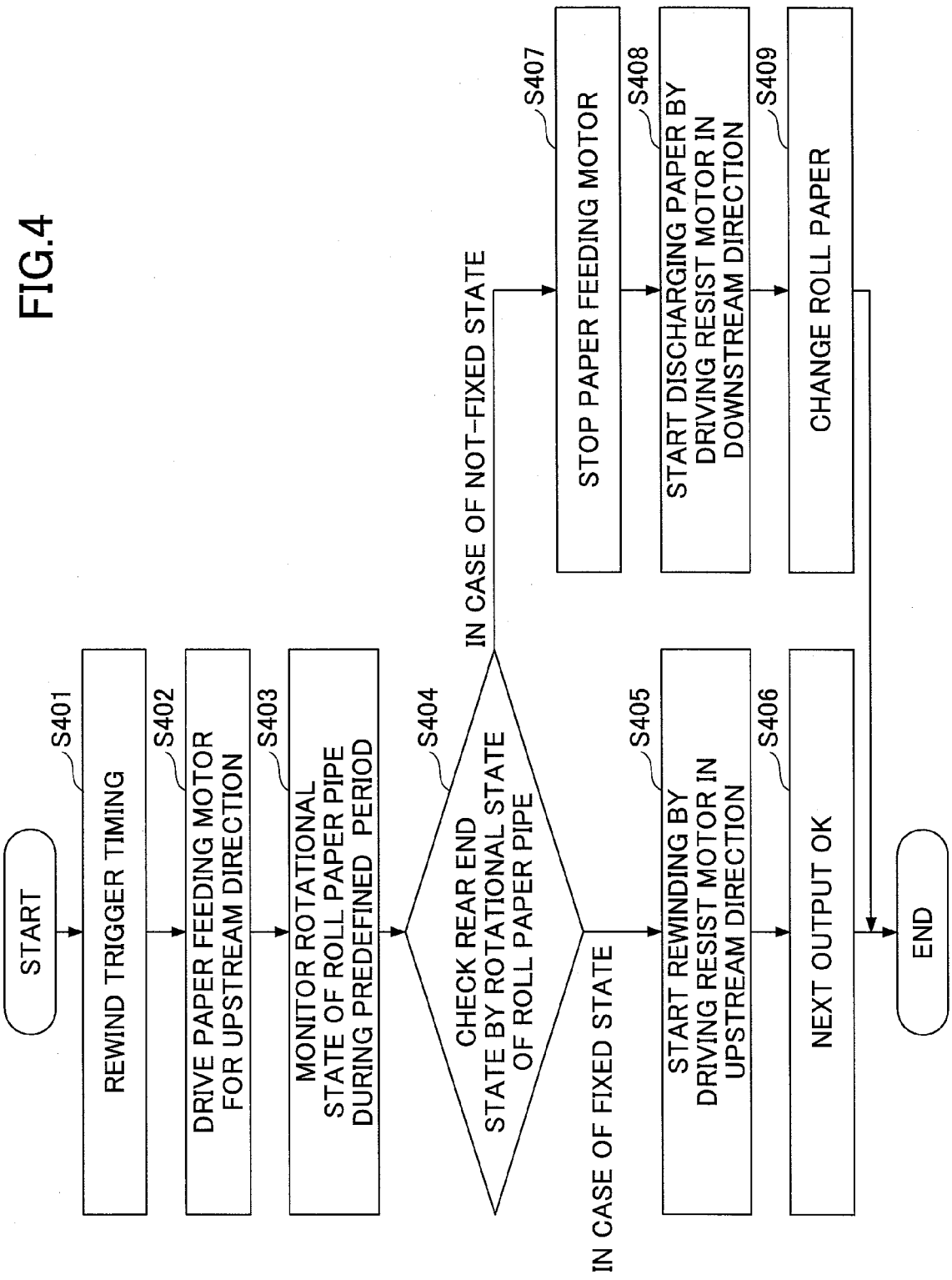

START
S401
REWIND TRIGGER TIMING
S402
DRIVE PAPER FEEDING MOTOR FOR UPSTREAM DIRECTION
S403
MONITOR ROTATIONAL STATE OF ROLL PAPER PIPE DURING PREDEFINED PERIOD
S404
CHECK REAR END STATE BY ROTATIONAL STATE OF ROLL PAPER PIPE
IN CASE OF NOT-FIXED STATE
S407
STOP PAPER FEEDING MOTOR
S408
START DISCHARGING PAPER BY DRIVING RESIST MOTOR IN DOWNSTREAM DIRECTION
S409
CHANGE ROLL PAPER
IN CASE OF FIXED STATE
S405
START REWINDING BY DRIVING RESIST MOTOR IN UPSTREAM DIRECTION
S406
NEXT OUTPUT OK
END

FIG.5C

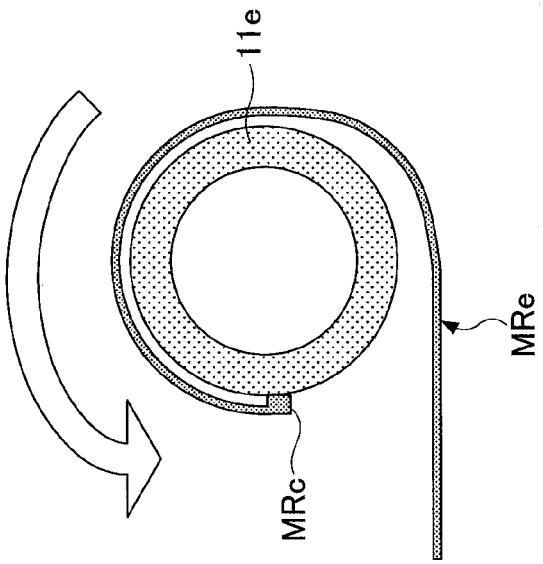


FIG.5B

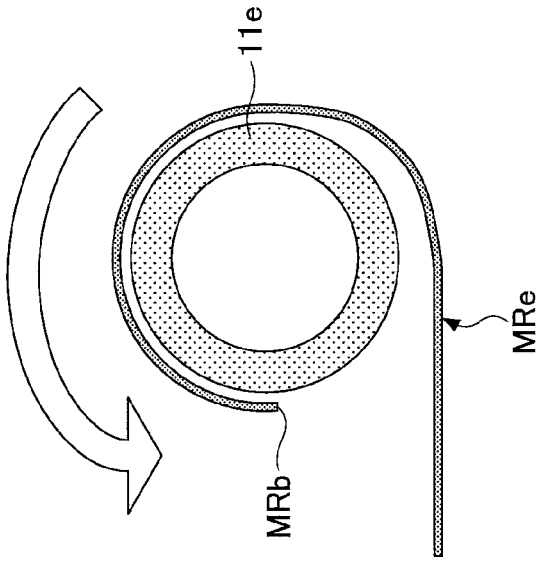


FIG.5A

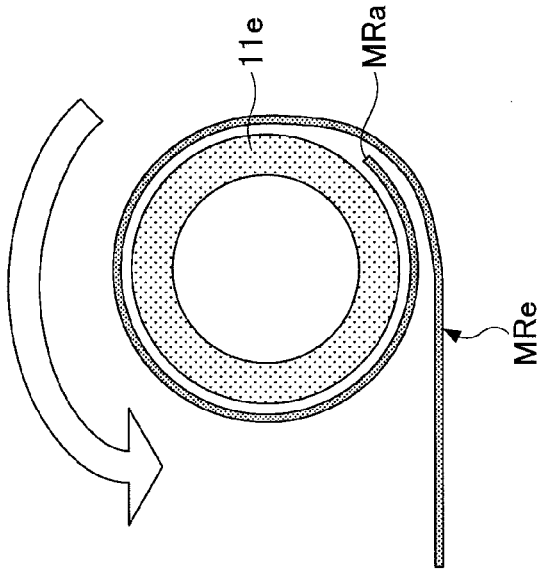
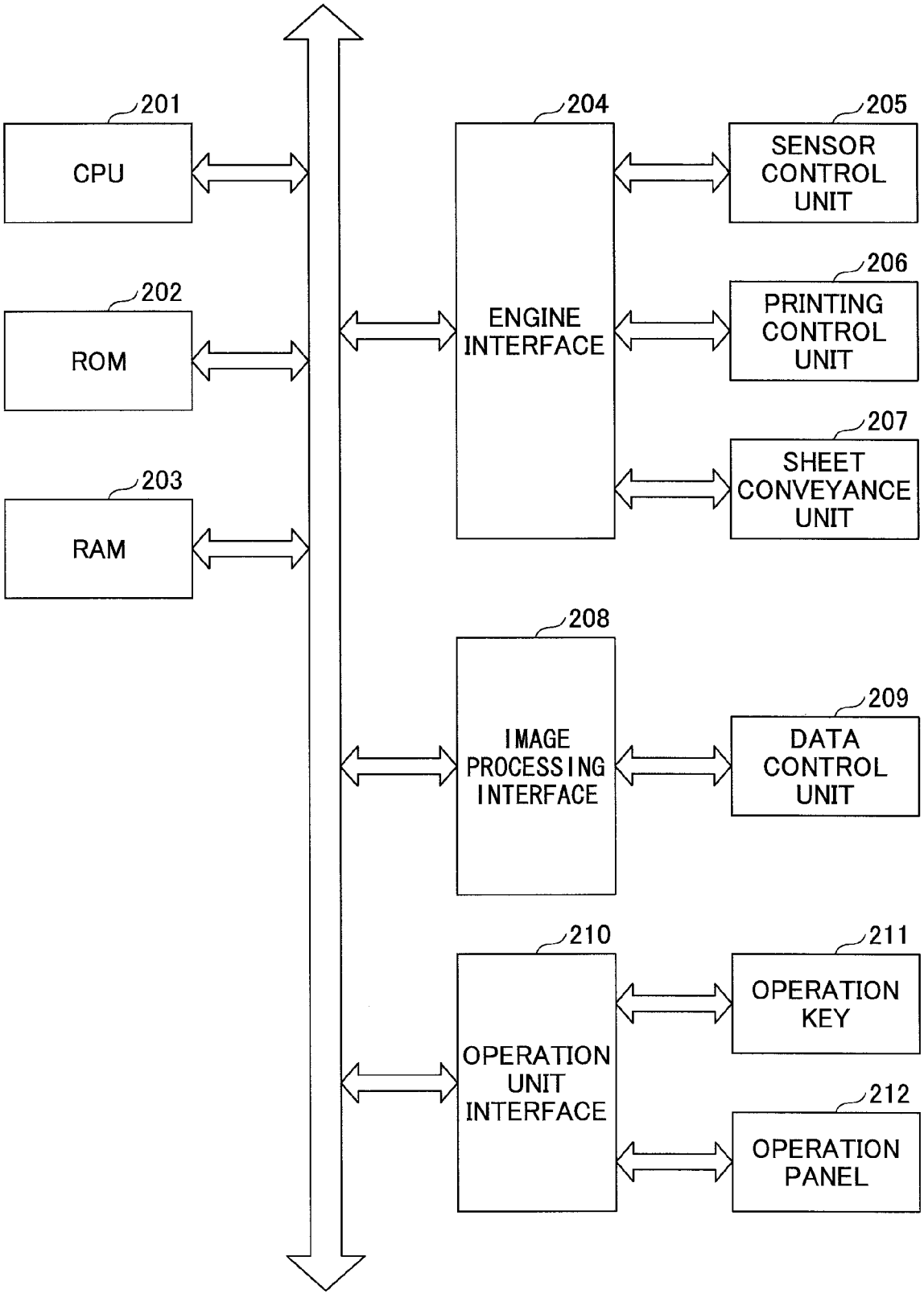


FIG.6


201
CPU
202
ROM
203
RAM
204
ENGINE INTERFACE
205
SENSOR CONTROL UNIT
206
PRINTING CONTROL UNIT
207
SHEET CONVEYANCE UNIT
208
IMAGE PROCESSING INTERFACE
209
DATA CONTROL UNIT
210
OPERATION UNIT INTERFACE
211
OPERATION KEY
212
OPERATION PANEL

RECORDING MEDIUM CONVEYANCE APPARATUS, IMAGE FORMING APPARATUS, RECORDING MEDIUM CONVEYANCE METHOD AND RECORDING MEDIUM STORING PROGRAM OF RECORDING MEDIUM CONVEYANCE METHOD

RELATED APPLICATIONS

The present application claims priority to and incorporates by reference the entire contents of Japanese Patent Application No. 2012-240240 filed in Japan on Oct. 31, 2012.

BACKGROUND OF THE INVENTION

1. Field of the Invention

The disclosures herein generally relate to a recording medium conveyance apparatus, an image forming apparatus and a recording medium conveyance method.

2. Description of the Related Art

In apparatuses such as image forming apparatuses in which a recording medium is used, a recording medium may be conveyed by rotating two rollers (roller pair) while the recording medium is nipped between the two rollers. Also, in image forming apparatuses, images may be formed on a surface of a long recording medium, the recording medium is cut off after forming the images, and the image formed cut-off part of the recording medium is discharged (ejected).

In Patent Document 1, a technology is disclosed, which is related to a recording apparatus capable of detecting existence or non-existence of slack of a roll of paper, or detecting a remaining amount of the roll of paper in accordance with a conveyance method.

[Patent Document 1] Japanese Patent Application Publication No. 2002-302313

SUMMARY OF THE INVENTION

A long recording medium (e.g., roll of paper) is rolled around a roll pipe (e.g., paper pipe for a roll paper) and installed in an image forming apparatus. Also, the installed long recording medium is fed to (rolled out to) the image forming apparatus continuously from a front end of the medium by the rotation of the roll pipe. Furthermore, the long recording medium is rolled back again and restored by a reverse rotation of the roll pipe.

In the technology disclosed in Patent Document 1, a long recording medium in some instances cannot be rolled back when restoring the recording medium after forming images. In the technology disclosed in Patent Document 1, for example, the rear end of the recording medium may be detached from the roll pipe, or there may be slack in the roll of the recording medium around the roll pipe. In such a case, the recording medium cannot be rolled back. Also, in the technology disclosed in Patent Document 1, an erroneous detection such as a paper jam detection may be made when the recording medium cannot be rolled back.

It is a general object of at least one embodiment of the present invention to provide a recording medium conveyance apparatus, an image forming apparatus or a method of recording medium conveyance that is configured to determine whether a rear end of a recording medium is fixed to a roll pipe or not by detecting a rotational operation of a roll pipe of an upstream side in a conveyance direction when the recording medium is held still at a downstream side.

According to an embodiment of the present invention, a recording medium conveyance apparatus for conveying a recording medium rolled around a roll pipe is provided, which recording medium conveyance apparatus includes a feeding unit configured to accommodate the roll pipe and feed the recording medium, a conveyance unit configured to convey the recording medium fed by the feeding unit and a determination unit configured to determine an accommodation state of the recording medium accommodated by the feeding unit. The feeding unit includes a driving unit configured to rotate the roll pipe and a detection unit configured to detect a rotational operation of the roll pipe. The conveyance unit, using at least two rollers, nips the recording medium with the rollers and conveys or holds still the recording medium. The determination unit determines whether the recording medium is fixed to the roll pipe based on the rotational operation of the roll pipe detected by the detection unit when the recording medium is held still by the rollers.

According to another embodiment of the present invention, an image forming apparatus is provided, which image forming apparatus includes the above conveyance apparatus and an image forming unit configured to form an image on the recording medium.

According to yet another embodiment of the present invention, a method of recording medium conveyance is provided, which method includes a feeding step of feeding a recording medium rolled around a roll pipe, a restoration step of restoring the fed recording medium, and a determination step of determining an accommodation state of the recording medium. In the feeding step, by rotating the roll pipe, the recording medium is fed continuously from the front end in the conveyance direction. In the restoration step, the downstream side of the fed recording medium is fixed, the recording medium is restored by reversely rotating the roll pipe, and a rotational operation of the roll pipe during the restoration is detected. In the determination step, it is determined whether the recording medium is fixed to the roll pipe based on the rotational operation of the roll pipe detected in the restoration step.

According to a recording medium conveyance apparatus, an image forming apparatus or a method of recording medium conveyance, it can be determined whether a rear end of a recording medium is fixed to a roll pipe or not by detecting a rotational operation of a roll pipe of an upstream side when the recording medium is fixed at a downstream side.

BRIEF DESCRIPTION OF THE DRAWINGS

Other objects and further features of embodiments will become apparent from the following detailed description when read in conjunction with the accompanying drawings.

FIG. **1** is a drawing illustrating an overview of an example of a recording medium conveyance apparatus according to an embodiment of the present invention.

FIG. **2** is a drawing illustrating a cross-sectional view of an example of a recording medium conveyance apparatus according to an embodiment of the present invention.

FIG. **3** is a drawing illustrating an example of a feeding unit of a recording medium conveyance apparatus according to an embodiment of the present invention.

FIG. **4** is a flowchart illustrating an example of an operation of a recording medium conveyance apparatus according to a first embodiment of the present invention.

FIGS. **5**A, **5**B and **5**C are drawings illustrating an example of a determination result determined by the recording medium conveyance apparatus according to the first embodiment of the present invention.

FIG. **6** is a functional block diagram illustrating an example of a function of an image forming apparatus according to a second embodiment of the present invention.

DESCRIPTION OF THE PREFERRED EMBODIMENTS

In the following, embodiments of the present invention will be described with reference to the accompanying drawings.

An embodiment of the present invention will be described using a conveyance apparatus that conveys a long recording medium rolled around a roll pipe. The present invention can be applied to, other than a conveyance apparatus described in the following, a medium feeding apparatus, a feeding tray detection apparatus, a conveying medium detection apparatus, an image forming apparatus, a recording apparatus, a copy machine, a multifunction machine, a printer, a scanner, a plotter, a facsimile, a fax machine, or anything (apparatus, device, unit, etc.) that uses a long recording medium. Also, regarding the recording medium that can be conveyed by a conveyance apparatus according to the present embodiment, it includes a long paper, a long sheet, a long thin paper, a long thick paper, a long recording sheet, a long OHP sheet, a long synthetic resin film, a long metal thin film, and other long media.

Note that in the following description, the same or a corresponding reference numeral is used for the same or a corresponding member or unit throughout the accompanying drawings, and duplicated descriptions will be omitted for the same or a corresponding member or unit. Also, in the following description, a long recording medium will be simply referred to a recording medium. Furthermore, a size of a member or unit shown in the drawings is not intended for showing a ratio to a size of other members or units. Therefore, actual sizes can be determined by a person skilled in the art in accordance with the following embodiments.

Using a recording medium conveyance apparatus according to an embodiment of the present invention, the present embodiments will be described in the following order.

1. Configuration of conveyance apparatus
2. Conveyance operations
3. Program of conveyance method and recording medium
4. First embodiment (conveyance apparatus)
5. Second embodiment (image forming apparatus including the conveyance apparatus)

Configuration of Conveyance Apparatus

Using FIG. **1** through FIG. **3**, a configuration of a recording medium conveyance apparatus (hereinafter, referred to as a conveyance apparatus **100**) according to the present embodiment will be described.

As shown in FIG. **1** and FIG. **2**, the conveyance apparatus **100** includes a feeding unit **10** configured to feed a recording medium MR rolled around a roll pipe **11**, and a conveyance unit **20** configured to convey the recording medium MR fed by the feeding unit **10**. Also, the conveyance apparatus **100** includes a determination unit (not shown in the figures) configured to determine an accommodation state of the recording medium MR accommodated by the feeding unit **10**. Furthermore, the conveyance apparatus **100** can include an input unit and an output unit (not shown in the figures) configured to output and input information to and from outside the conveyance apparatus **100**. Note that the conveyance apparatus **100** may also include a control unit (not shown in the figure) configured to control operations of the conveyance apparatus **100**.

The conveyance apparatus **100**, using the feeding unit **10** (roll pipe, driving unit, etc.), accommodates the recording medium MR and feeds the recording medium MR to a conveyance unit **20**. Also, the conveyance apparatus **100**, using the conveyance unit **20** (conveyance roller, etc.), conveys (moves, moves in, moves out, nips, holds still, etc.), the recording medium MR. Furthermore, the conveyance apparatus **100**, using the determination unit, determines the accommodation state of the recording medium MR accommodated by the feeding unit **10**. Note that the accommodation state refers to an arrangement state (e.g., rolling state) of the recording medium MR rolled around the roll pipe **11** of the feeding unit **10**.

The feeding unit **10** is a unit for feeding the recording medium MR. The feeding unit **10** includes the roll pipe **11** for rolling and retaining the recording medium MR, a driving unit **12** for rotating the roll pipe **11**, and a detection unit **13** for detecting a rotational operation of the roll pipe **11**.

The roll pipe **11** is for rolling and retaining the recording medium (long recording medium) MR. The roll pipe **11** can use a member (e.g., paper pipe, cylinder pipe, circular cylinder, etc.) around which the long recording medium MR can be rolled. Regarding the roll pipe **11**, a spool axle **11***x* (see FIG. **1** and FIG. **3**) is detachably placed in the conveyance apparatus **100**. By this, a user, after using the rolled recording medium MR, can exchange the used roll pipe with a new roll pipe around which a new recording medium MR is rolled.

Note that the roll pipe **11** can retain a recording medium MR (roll of paper, etc.) of a different size in terms of width or in terms of axis direction (a direction shown in "A" in FIG. **1**). Also, the roll pipe **11** may include flanges for holding both ends of the roll of recording medium MR.

The driving unit **12** is for feeding the recording medium MR retained by the roll pipe **11** to the conveyance unit **20** (described later) continuously from an end (front end) of the recording medium MR by rotating the roll pipe **11** (forward rotation). The driving unit **12** is, also, for rolling back (restoring) the recording medium MR fed to the conveyance unit **20** by rotating the roll pipe **11** (backward rotation). Here, the driving unit **12** can, for example, using a driving force of a motor (not shown in the figure), rotate the roll pipe **11** (or flanges) in the forward direction or in the backward direction by rotating the spool axle **11***x*. Furthermore, in this embodiment, the driving unit **12** includes a clutch member **12***c* for transmitting power to the roll pipe **11**.

The clutch member **12***c* transmits the power of the motor to the roll pipe **11** (or the spool axle **11***x*) in the case where the roll pipe **11** can be driven with less than a certain amount of power, and does not transmit the power of the motor to the roll pipe **11** in the case where the roll pipe **11** cannot be driven with less than a certain amount of power. By this, the driving unit **12** (the conveyance apparatus **100**) can control the rotational operation of the roll pipe **11**.

To be more precise, as shown in FIG. **3**, the clutch member **12***c* connects the spool axle **11***x* of the roll pipe **11** to a driving axle **12**Mx of the motor via gears (toothed wheels), etc. Also, the clutch member **12***c* locks in the direction (backward direction, or restoring direction) for rolling back the recording medium MR, and does not lock in the forward direction (conveyance direction). That is, in the case where the driving unit **12** rolls back the recording medium MR, when more than the certain amount of power is required for rotating the roll pipe **11**, the clutch member **12***c* does not transmit the power of the motor to the roll pipe **11** by freeing the power in the forward direction. By this, the driving unit **12**, in the case of

rolling back the recording medium MR, can perform control of not rotating (rotating backward) (restoring) the roll pipe **11**.

Here, the certain amount of power can take any value corresponding to the type (thickness) of the recording medium MR and the specification of the feeding unit **10** (or the roll pipe **11**). Also, the certain amount of power can take a value further corresponding to other specifications of the conveyance apparatus **100**. Furthermore, the certain amount of power can take a value predefined based on an experiment, a calculation, etc.

Furthermore, the driving unit **12** may include a torque limiter. By this, the driving unit **12** can convey (feed or restore) the recording medium MR while applying a tensional force (applying a backward tension) to the recording medium MR. Also, in the case where the conveyance apparatus **100** is installed in an image forming apparatus, the conveyance apparatus **100** can, by transmitting the power using the torque limiter, avoid slack of the recording medium MR when repeating a discontinuous conveyance. Furthermore, in the case where the conveyance apparatus is installed in an image forming apparatus, the conveyance apparatus **100** can, by transmitting the power using the torque limiter, avoid slack of the recording medium MR when rolling back the recording medium MR by a resist roller (to be described later).

The detection unit **13** is for detecting the rotational operation of the roll pipe **11**. The detection unit **13** detects as a rotational operation of the roll pipe **11**, for example, a number of rotations of the spool axle **11***x* of the roll pipe **11**. Also, the detection unit **13** may further detect, for example, a number of rotations of the motor of the driving unit **12**.

To be more precise, as shown in FIG. **3**, the detection unit **13** can, by using an encoder **13***sa*, detect a number of rotations of the spool axle **11***x* of the roll pipe **11**. Also, the detection unit **13** may, by using an encoder **13***sb*, detect a number of rotations of the driving axle **12**Mx of the driving unit **12**. Note that regarding the detection unit **13**, a photo sensor, a rotary encoder, an encoder sensor, an optical sensor, a magnetic sensor, an electrostatic sensor, a direct acting type sensor, a motor built-in rotational phase detector, etc., can be used.

Also, the conveyance apparatus **100** can, based on a detection result detected by the encoder **13***sa* and the encoder **13***sb*, control a rotational operation of the roll pipe **11** and the operation of the motor. Also, the conveyance apparatus **100** can, based on a detection result detected by the encoder **13***sb* placed in the upstream side of the clutch member **12***c* and the encoder **13***sa* placed in the downstream side, control the operation of the clutch member **12***c*.

Furthermore, in the case where the conveyance unit **20** to be described later (conveyance roller) holds still the recording medium MR, when the driving unit **12** rotates the spool axle **11***x* and restores the recording medium MR, the detection unit **13** detects a number of rotations of the spool axle **11***x*. Also, the detection unit **13** may start the detection of the rotational operation of the roll pipe **11** (e.g., a number of rotations of the spool axle **11***x*) a predefined period of time after the driving unit **12** rotates the spool axle **11***x*. By this, the detection unit **13** (the conveyance apparatus **100**) can further accurately detect the rotational operation of the roll pipe **11** because disturbances such as slack of the recording medium MR, etc., can be eliminated.

Here, the predefined period of time can be a period corresponding to specifications of a type of the recording medium MR and/or the feeding unit **10**. Also, the predefined period of time can be a period corresponding to other specifications of the conveyance apparatus **100**. Furthermore, the predefined period of time can be a period defined in advance by an experiment or a calculation, etc. The predefined period of time can be, for example, a second or two seconds.

The conveyance unit **20** is a unit for moving (conveying) or holding still the recording medium MR. The conveyance unit **20**, by using the conveyance rollers **21***a* and **21***b* (correspond to the "two rollers" in the claims), conveys or holds still the recording medium MR. Note that the conveyance unit **20** may convey or hold still the recording medium MR by using two or more rollers.

To be more precise, as shown in FIG. **2**, the conveyance unit **20** uses, as the conveyance rollers, a driving roller (resist roller) **21***a* and a following roller (pressurized roller) **21***b*. Also, the conveyance unit **20** may further use, as the conveyance rollers, a roller pair **21***c*. The conveyance unit **20** is capable of, having the recording medium MR nipped between the driving roller **21***a* and the following roller **21***b*, by rotating the driving roller **21***a* in the forward direction (forward rotation), conveying the recording medium MR in the conveyance direction. Also, the conveyance unit **20** is capable of, having the recording medium MR nipped between the driving roller **21***a* and the following roller **21***b*, by rotating the driving roller **21***a* in the reverse direction, conveying the recording medium MR in the reverse direction (hereinafter, referred to as "restoring direction"). Furthermore, the conveyance unit **20** is capable of, having the recording medium MR nipped between the driving roller **21***a* and the following roller **21***b*, by stopping the driving roller **21***a*, holding still the recording medium MR. That is, the conveyance unit **20** is capable of, by using the driving roller **21***a*, etc., conveying or holding still the recording medium MR.

The determination unit is a unit for determining the accommodation state of the recording medium MR. The determination unit determines the accommodation state of the recording medium MR retained by the roll pipe **11** of the feeding unit **10** based on a detection result detected by the detection unit **13** of the feeding unit **10**. The determination unit can determine whether the recording medium MR is fixed to (retained by, remaining on, etc.) the roll pipe **11** or not based on the rotational operation of the roll pipe **11** detected by the detection unit **13**. Also, the determination unit can determine whether the recording medium MR is fixed, etc., to the roll pipe **11** (or flanges) based on the number of rotations of, for example, the spool axle **11***x* (or flanges) of the roll pipe **11** detected by the detection unit **13**.

To be more precise, the determination unit, in the case where the recording medium MR is held still by the driving roller **21***a*, regarding the rotational operation of the roll pipe **11** detected by the detection unit **13**, determines that the recording medium MR is fixed to the roll pipe **11** when the number of rotations of the spool axle **11***x* is less than a predefined number of rotations. By this, the determination unit (the conveyance apparatus **100**) can determine the accommodation state of the recording medium MR (e.g., the state of the rear end of the recording medium MR) in accordance with the specifications or the characteristics of the conveyance apparatus **100**. Note that the determination unit may determine whether the recording medium MR is fixed, etc., to the roll pipe **11**, by further using information (e.g., information on the types, etc., of the recording medium MR, information on a threshold value) inputted by an input unit (described later).

Here, it can be assumed that the predefined number of rotations is a number of rotations corresponding to the specifications of the feeding unit **10** (or the roll pipe **11** or the flanges). Also, it can be assumed that the predefined number of rotations is a number of rotations further corresponding to other specifications of the conveyance apparatus **100**. Furthermore, it can be assumed that the predefined number of

rotations is a number of rotations defined in advance based on an experiment or a calculation.

The input unit is a unit for inputting information (e.g., electrical signals) from outside the conveyance apparatus **100**. The input unit inputs information related to operations of the conveyance apparatus **100** from an external apparatus (PC, etc.) The input unit can input, for example, a predefined period of time before the detection unit **13** starts the detection and/or a predefined number of rotations that is used when the determination unit makes the determination.

The output unit is a unit for outputting information (e.g., electrical signals) to outside the conveyance apparatus **100**. The output unit outputs information related to operations of the conveyance apparatus **100** to an external apparatus (PC, etc.) The output unit can output, for example, an accommodation state determined by the determination unit and/or a conveyance result of the conveyance unit **20** when the conveyance unit **20** conveys the recording medium MR by reversely rotating the driving roller (resist roller) **21***a*.

The input unit and the output unit can include an input member (e.g., a user interface such as an operation panel) to which information (information on the recording medium MR, etc.) is inputted. Also, the input unit and the output unit can include an output member (e.g., a display member such as a touch panel) with which information is outputted (displayed) outside the conveyance apparatus **100**.

A control unit is a unit for instructing components of the conveyance apparatus **100** to operate and controlling the components' operations. The control unit controls operations of feeding and restoring the recording medium MR by controlling the operations of the feeding unit **10**. Also, the control unit controls operations of conveying (moving, moving in, moving out, nipping, holding still, etc.) the recording medium MR by controlling the operations of the conveyance unit **20**. Also, the control unit controls operations of determining the accommodation state of the recording medium MR accommodated by the feeding unit **10** by controlling the operations of the determination unit. The control unit further controls operations of inputting and outputting information between the conveyance apparatus **100** and outside the conveyance apparatus **100** by controlling the operations of the input unit and the output unit.

Note that the control unit may be configured to be a processor including a CPU (Central Processing Unit) of known technology, a memory, etc. Also, the control unit, using, for example, a program (control program, application, etc.) stored in advance, may control the operations of the components of the conveyance apparatus **100**. The control unit may, further based on information, etc., inputted from the input unit, control the operations of the components of the conveyance apparatus **100**.

Operations of Conveyance

An example of operations of the conveyance apparatus according to the present embodiment will be described.

The conveyance apparatus **100** (FIG. **1** through FIG. **3**), in a feeding step, feeds the recording medium MR accommodated by the roll pipe **11**, around which the recording medium MR is rolled. Next, the conveyance apparatus **100**, in a conveyance step, conveys the fed recording medium MR in the conveyance direction.

Also, the conveyance apparatus **100**, in a restoration step, restores the fed recording medium MR. At this time, the conveyance apparatus **100**, in a determination step, determines the accommodation state of the accommodated recording medium MR.

To be more precise, in the feeding step, the recording medium MR is fed continuously from a front end of the recording medium MR in the conveyance direction by rotating the roll pipe **11** (forward rotation) using the driving unit **12**. Next, in the conveyance step, the recording medium MR is moved in the conveyance direction by using the driving roller **21***a*, etc.

In the restoration step, by using the driving roller **21***a*, etc., the recording medium MR is held still at the downstream side. Next, by reversely rotating the roll pipe **11** by using the driving unit **12**, the recording medium MR is restored to the feeding unit **10**. At this time, the feeding unit **10** detects the rotational operation of the roll pipe **11** during the restoration by using the detection units **13***sa*, **13***sb*. Next, in the determination step, by using the determination unit, based on the rotational operation of the roll pipe **11** detected in the restoration step, it is determined whether the recording medium MR is fixed to the roll pipe **11** or not.

In the determination step, regarding the rotational operation of the roll pipe **11** detected by the detection units **13***sa*, **13***sb*, when a number of rotations of the spool axle **11***x* (the roll pipe **11**) is less than a predefined number of rotations, it can be determined that the recording medium MR is fixed to the roll pipe **11**.

Also, in the restoration step, in the case where it is determined that the recording medium MR is fixed to the roll pipe **11**, the speed of restoring (rewinding) the recording medium MR by rotating (reverse rotation) the roll pipe **11** is caused to be greater than the speed of conveying the recording medium MR by rotating (reverse rotation) the conveyance rollers **21***a* and **21***b* or **21***c*. By this, the feeding unit **10** (the conveyance apparatus **100**) can reduce the occurrence of a paper jam caused by the pushing from the downstream side.

On the other hand, in the case where the determination unit determines that the recording medium MR is not fixed to the roll pipe **11**, the recording medium MR is conveyed in the conveyance direction by rotating (forward rotation) the conveyance rollers **21***a*, **21***b*. At this time, the conveyance unit **20** causes the speed of conveying the recording medium MR by rotating (forward rotation) the conveyance rollers **21***a*, **21***b* to be greater than the speed of feeding (discharging) the recording medium MR by rotating (forward rotation) the roll pipe **11** by the driving unit **12**. By this, the conveyance unit **20** (the conveyance apparatus **100**) can reduce the occurrence of a paper jam caused by the pushing from the upstream side.

Furthermore, the conveyance apparatus **100** may, as an output step, using the output unit, output the determination result determined by the determination unit. By this, the conveyance apparatus **100** can inform a user about the reason of discharging the recording medium MR (e.g., the rear end of the recording medium MR is not fixed).

Program and Recording Medium in which the Program is Recorded

According to a program of a conveyance method of the present embodiment, a method of recording medium conveyance is executed, which method includes a feeding step of feeding a recording medium accommodated by being rolled around a roll pipe, a restoration step of restoring the fed recording medium, and a determination step of determining an accommodation state of the accommodated recording medium. In the feeding step, the recording medium is fed continuously from the front end of the recording medium in the conveyance direction. In the restoration step, the downstream side of the fed recording medium is held still, the recording medium is restored by reversely rotating the roll

pipe, and rotational operation of the roll pipe during the restoration is detected. In the determination step, based on the rotational operation of the roll pipe detected in the restoration, it is determined whether the recording medium is fixed to the roll pipe. According to this configuration, effects equivalent to the conveyance apparatus **100** of the present embodiment can be obtained.

Also, an embodiment of the present invention may be a computer readable recording medium Md in which the above program is recorded. Regarding the recording medium Md in which the above program is recorded, a flexible disk (FD), a CD-ROM (Compact Disk-ROM), a CD-R (CD Recordable), a DVD (Digital Versatile Disk), other computer readable media, a semiconductor memory such as a flash memory, a RAM, a ROM, etc., a memory card, a HDD (Hard Disk Drive), and other computer readable media can be used.

As described above, according to the conveyance apparatus **100** of the recording medium of the present embodiment, by using the feeding unit **10**, the conveyance unit **20** and the determination unit, the rotational operation of the roll pipe **11** of the upstream side when the recording medium MR is fixed at the downstream side can be detected. Also, it can be determined whether the rear end of the recording medium MR is fixed to the roll pipe **11** because the rotational operation of the roll pipe **11** of the upstream side when the recording medium MR is fixed at the downstream side can be detected. Furthermore, it can be selected whether to restore the recording medium MR back to the feeding unit **10** or to discharge the recording medium MR by using the conveyance unit **20** because it can be determined whether the rear end of the recording medium MR is fixed to the roll pipe **11** or not.

Also, the state of the rear end of the recording medium MR can be determined without conveying the recording medium MR because it can be determined whether the rear end of the recording medium MR is fixed to the roll pipe **11** or not by using the determination unit, etc. Also, because the state of the rear end of the recording medium MR can be determined, a conveyance route of the recording medium MR can be released and a limitless paper feeding (feeding another recording medium MR successively) can be provided. Furthermore, taking into consideration slack of the recording medium MR (roll paper, etc.) that occurs after the end of conveyance, whether it is possible to rewind the recording medium MR onto the roll pipe **11** or not can be determined just before the rewinding. Therefore, a switching operation can be executed in which the rewinding is performed when it is possible to do the rewinding and the rewinding is stopped and the discharging in the downstream direction is performed when it is not possible to do the rewinding. By this, it becomes possible to reduce unnecessary paper jam occurrences (to reduce jam removing work, to reduce machine damage due to jams, and to reduce down time due to jams).

Also, the state of the rear end of the recording medium MR can be accurately determined because it can be determined whether the rear end of the recording medium MR is fixed to the roll pipe **11** or not by using the determination unit, etc. Also, because the state of the rear end of the recording medium MR can be accurately determined, unnecessary jam occurrences can be avoided, user's workload for the after-treatment is reduced, and/or the down time can be reduced.

Also, because the state of the rear end of the recording medium can be determined, it is not necessary to place a sensor in the conveyance route as opposed to "a method of detecting the state of the rear end using a sensor placed in the conveyance route". Also, because the state of the rear end of the recording medium MR can be determined by using the determination unit, etc., the state of the rear end of the recording medium can be determined even when the recording medium is a medium (e.g., transparent medium) that cannot be detected by a sensor (e.g., optical sensor). That is, the number of components of the apparatus can be reduced, the structure of the apparatus can be simplified and the apparatus can be downsized. Note that in the case where the conveyance apparatus **100** is installed in an image forming apparatus, etc., the conveyance apparatus **100** may be configured to include a sensor placed in the conveyance route, and the front end of the recording medium MR (e.g., whether the recording medium is conveyed to the place where the sensor is placed) can be detected, or the conveyance state (e.g., the rear end) of the recording medium that is conveyed in the conveyance direction (downstream direction) can be detected.

Furthermore, chronological changes of the recording medium MR due to a change of temperature and moisture can be taken into consideration as opposed to a "method detecting from a change of an encoder of a roll paper pipe or a feeding motor (abrupt increase, spinning around)".

EMBODIMENTS

The present invention will be described using embodiments of a recording medium conveyance apparatus and an image forming apparatus including the recording medium conveyance apparatus.

First Embodiment

The present invention will be described using a conveyance apparatus **100**E of a first embodiment.

Configuration of the Conveyance Apparatus

A configuration of the conveyance apparatus **100**E according to the present embodiment is shown in FIG. **1** through FIG. **3**. Here, the configuration of the conveyance apparatus **100**E is basically the same as that of the conveyance apparatus **100**, and the description is omitted. Note that in this embodiment, the conveyance apparatus **100**E uses, as the recording medium MR, a roll paper MRe. Also, the conveyance apparatus **100**E uses, as the roll pipe **11**, a roll paper pipe **11***e*. Also, the conveyance apparatus **100**E uses, as the driving unit **12**, a paper feeding motor **12***e*. Furthermore, the conveyance apparatus **100**E uses, as a driving unit of the conveyance rollers **21***c*, a resist motor **21***e*.

Conveyance Operations

An example of operations of conveying the roll paper MRe by the conveyance apparatus **100**E will be described using FIG. **4**, FIGS. **5**A, **5**B and **5**C. In the following, in the case where the conveyance apparatus **100**E is installed in an image forming apparatus, operations of rewinding the roll paper MRe to a standby position in order to release an image forming unit after forming the image are described.

As shown in FIG. **4**, the conveyance apparatus **100**E, as a restoring step, in step S**401**, starts an operation of rewinding the roll paper MRe. The conveyance apparatus **100**E starts the rewinding operation, for example, after forming an image. Also, information related to the start of the rewinding operation is inputted to the conveyance apparatus **100**E by a user, for example, by using an input unit. After that, the conveyance apparatus **100**E moves to step S**402**.

In step S**402**, the conveyance apparatus **100**E, using the paper feeding motor **12***e*, starts moving the roll paper MRe to

the upstream side in the conveyance direction. After starting the moving, the conveyance apparatus **100**E moves to step S**403**.

In step S**403**, the conveyance apparatus **100**E, using the detection unit **13**, monitors the rotational state of the roll paper pipe **11***e*. Here, the detection unit **13**, using an encoder **13***sa*, detects the rotational state of the roll paper pipe **11***e* (e.g., driving time, driving amount, etc.) during a predefined period of time (after a predefined period of time). Also, the detection unit **13** may, in the case where there are disturbances such as slack of the roll paper MRe, detect the rotational state after a predefined period of time after the start of the moving in step S**402**. After that, the conveyance apparatus **100**E moves to step S**404**.

In step S**404**, the conveyance apparatus **100**E, using the determination unit, based on a monitoring result (a detection result detected by the detection unit **13**) in step S**403**, determines the state (accommodation state) of the rear end of the roll paper MRe of the roll paper pipe **11***e*. The conveyance apparatus **100**E moves to step S**405** in the case where it is determined that the state of the rear end of the roll paper MRe of the roll paper pipe **11***e* is a "fixed state". Also, the conveyance apparatus **100**E moves to step S**407** in the case where it is determined that the state of the rear end is a "not-fixed state".

To be more precise, the determination unit can determine the state of the rear end of the roll paper MRe as shown in the following (1) through (5).

(1) In the case where it is determined by an encoder change amount during a predefined period of time, the determination unit, by setting a threshold value as "zero", determines that the roll paper pipe **11***e* is not rotating when the encoder change amount is "zero". By this, the determination unit can determine that the rear end of the roll paper MRe is in the "fixed state" (e.g., FIG. **5**A or FIG. **5**C).

(2) In the case where it is determined by an encoder change amount during a predefined period of time, the determination unit, by setting a threshold value as "zero", determines that the roll paper pipe **11***e* alone is spinning around when the encoder change amount is not "zero". By this, the determination unit can determine that the rear end of the roll paper MRe is in the "not-fixed state" (e.g., FIG. **5**B).

(3) In the above (1) or (2), in the case where the disturbances cannot be completely removed, the determination unit, using a threshold value other than "zero", determines the same as the above (1) or (2).

(4) In the case where it is determined by an encoder speed change during a predefined period of time, the determination unit, by setting the rotational speed of the roll paper pipe **11***e* alone when the remaining amount of the roll paper MRe is zero as a threshold value, determines that the roll paper pipe **11***e* alone is spinning around when the encoder speed change is equal to or greater than the threshold value. By this, the determination unit can determine that the rear end of the roll paper MRe is in a "not-fixed state" (e.g., FIG. **5**B).

(5) In the case where it is determined by an encoder speed change during a predefined period of time, the determination unit determines that the roll paper pipe **11***e* is not rotating when the encoder speed change is less than the threshold value. By this, the determination unit can determine that the rear end of the roll paper MRe is in a "fixed state" (e.g., FIG. **5**A or FIG. **5**C).

In step S**405**, the conveyance apparatus **100**E, by using the resist motor **21***e*, starts an operation of rewinding the roll paper MRe to the upstream side in the conveyance direction. After the start, the conveyance apparatus **100**E moves to step S**406**. Note that, in order to avoid the occurrence of a jam or slack, the conveyance apparatus **100**E causes the sheet line speed of the upstream side (restoring speed by the paper feeding motor **12***e*) to be greater than the sheet line speed of the downstream side in the conveyance direction (conveyance speed by the resist motor **21***e*). Also, the conveyance apparatus **100**E can determine the line speed of the paper feeding motor **12***e* (rotational speed) based on the remaining amount of the roll paper MRe. Furthermore, the conveyance apparatus **100**E may change the sheet line speed (change the sheet line speed without stopping, or stop and restart) as necessary.

In step S**406**, the conveyance apparatus **100**E ends the rewinding operation. By this, the conveyance apparatus **100**E stands ready for the following operations. After that, the conveyance apparatus **100**E moves to "END" and ends the operation of conveying the roll paper MRe.

On the other hand, in step S**407**, the conveyance apparatus **100**E stops the paper feeding motor **12***e*. After that, the conveyance apparatus **100**E moves to step S**408**. That is, the conveyance apparatus **100**E stops restoring the roll paper MRe onto the roll paper pipe **11***e*. Note that the conveyance apparatus **100**E may move to the next step (step S**408**) without stopping the paper feeding motor **12***e*.

In step S**408**, the conveyance apparatus **100**E, by using the resist motor **21***e*, discharges the roll paper MRe (to the downstream side) in the conveyance direction. After that, the conveyance apparatus **100**E moves to step S**409**. To be more precise, in order to avoid the occurrence of a jam or slack, the conveyance apparatus **100**E causes the sheet line speed of the downstream side (discharging speed of the resist roller **21***e*) to be greater than the sheet line speed of the upstream side in the conveyance direction (supplying speed of the paper supply roller **12***e*). Also, the conveyance apparatus **100**E may drive the paper feeding motor **12***e* at any line speed (rotational speed). Furthermore, the conveyance apparatus **100**E may cause the line speed of the paper feeding motor **12***e* to be less than the line speed of the resist motor **21***e*.

Note that the conveyance apparatus **100**E may not drive the paper feeding motor **12***e*. Also, the conveyance apparatus **100**E may determine whether to drive the paper feeding motor **12***e* based on a paper type, a paper thickness, etc.

In step S**409**, the conveyance apparatus **100**E, at the end of discharging of the roll paper MRe, displays the same in the operation panel (output unit). By this, the user can recognize the timing of changing of the roll paper MRe. Note that the conveyance apparatus **100**E is configured to be able to automatically feed other roll papers, etc., from other paper feeding unit. By this, the conveyance apparatus **100**E can feed a new roll paper without waiting for a user to change the roll paper, and can shorten the amount of time needed for feeding a new roll paper. After that, the conveyance apparatus **100**E moves to "END" in the figure and ends the operation of conveying the roll paper MRe.

FIGS. **5**A, **5**B and **5**C show the states of the rear end of the roll paper MRe, which states are determined by the conveyance apparatus **100**E. Here, the conveyance apparatus **100**E determines that the state of the rear end is a not-fixed state in the case where the roll paper pipe **11***e* rotates when the paper feeding motor **12***e* is driven in the upstream direction in a state in which the downstream side of the roll paper MRe is held still (a state in which it is not moved by an excitation of the resist motor **21***e*).

As shown in FIG. **5**A, the rear end MRa of the roll paper MRe is caught between the roll paper pipe **11***e* and the downstream part of the roll paper MRe itself. That is, the state of the rear end of the roll paper MRe is a "fixed state".

As shown in FIG. **5**B, the rear end MRb of the roll paper MRe is not caught between the roll paper pipe **11***e* and the

downstream part of the roll paper MRe itself. That is, the state of the rear end of the roll paper MRe is a "not-fixed state".

As shown in FIG. **5**C, the rear end MRc of the roll paper MRe is connected to the roll paper pipe **11***e*. That is, the state of the rear end of the roll paper MRe is a "fixed state".

As described above, the conveyance apparatus **100**E of the first embodiment can obtain the same effects as the conveyance apparatus **100**.

Second Embodiment

The present embodiment will be described using an image forming apparatus **200**, which includes the conveyance apparatus **100**, according to a second embodiment of the present invention. Here, in the present embodiment, the image forming apparatus **200** is a serial type ink-jet recording apparatus. Note that the image forming apparatus of the present embodiment is not limited to a serial type. Also, the image forming apparatus of the present embodiment is not limited to an ink-jet recording apparatus.

Configuration of the Image Forming Apparatus

Using FIG. **1** through FIG. **3**, the configuration of the image forming apparatus **200** will be described. Note that because the configuration of the image forming apparatus **200** includes the configuration of the conveyance apparatus **100**, things that are different from the configuration of the conveyance apparatus **100** will be mainly described.

As shown in FIG. **1**, the image forming apparatus **200** of the present embodiment further includes an image forming unit **60** that forms images on the recording medium MR. Also, the image forming apparatus **200** may further include an image reading unit for reading images recorded (formed) on originals and an original conveyance unit for conveying the originals.

The image forming unit **60** is a unit for forming images on surfaces of the recording medium MR. The image forming unit **60** includes a guide rod **63** and a guide rail **64** which are placed between a pair of side plates (not shown in the figure), and a carriage **65** that is configured to be slidable with respect to the guide rod **63**, etc., in a direction indicated by an arrow "A" as shown in FIG. **1**.

Installed in the carriage **65** are liquid jetting heads that jet an ink drop of colors of black (K), yellow (Y), magenta (M) and cyan (C). Each of the heads may include a sub tank integrated with the head for supplying ink.

A main scanning mechanism, which moves the carriage **65** for scanning, includes a driving motor **62**M configured to be placed in one side in the main scanning direction, a driving pulley **62**P configured to be driven to rotate by the driving motor **62**M, and a following pulley **62**N configured to be placed in the other side in the main scanning direction. Also, the main scanning mechanism further includes a belt member **62**B configured to be placed between the driving pulley **62**P and the following pulley **62**N.

The following pulley **62**N, by using a tension spring (not shown in the figure), puts a tension to the belt member **62**B in a direction for moving away from the driving pulley **62***p*.

The belt member **62**B, by being fixed to a belt fixing unit that is included in the back side of the carriage **65**, moves the carriage **65** in the main scanning direction (a direction indicated by the arrow "A").

Also, an encoder sheet (not shown in the figure) for detecting a scanning location of the carriage **65** along the main scanning direction is placed, and the encoder sheet is read by an encoder sensor (not shown in the figure) included in the carriage **65**.

In a recording area of the scanning area of the carriage **65**, the roll paper MRe is conveyed by a sheet suction conveyance unit **67** intermittently in a direction (sub-scanning direction: direction indicated by an arrow "B") orthogonal to the scanning direction of the carriage **65**. Also, in an area of an end of the main scanning area, a maintenance and restoration mechanism **68** for maintenance and restoration of the recording heads is placed. Furthermore, a main cartridge **69** for containing each of the colors of ink for supplying to the sub tanks of the recording heads is installed detachably outside the carriage moving area in the main scanning direction or in an area of the other end of the main scanning area.

The image forming apparatus **200**, by using the conveyance unit **20** (roller pair **21***c*, resist roller **21***a* and the pressurized roller **21***b*, etc.), conveys the roll paper MRe fed by a roll paper accommodation unit (feeding unit **10**) to a recording area in a direction from the rear to the front of the image forming apparatus **200**.

Also, the image forming apparatus **200**, while moving the carriage **65** in the main scanning direction and conveying the roll paper MRe intermittently using the resist roller **21***a* and the pressurized roller **21***b*, drives the recording heads according to image information. At this time, the image forming apparatus **200** forms certain images on the roll paper MRe by jetting liquid drops (ink) from the recording heads.

Furthermore, the image forming apparatus **200** cuts the image formed roll paper MRe in a predefined length and discharges it into a copy receiving tray (not shown in the figure) configured to be placed in the front side of the image forming apparatus **200**. At this time, the image forming apparatus **200**, after conveying (rewinding) the part of the roll paper MRe, for the next image forming, to the resist roller **21***a* and the pressurized roller **21***b*, releases a nip of the roller pair **21***c*.

Functions of the Image Forming Apparatus

Using FIG. **6**, functions of the image forming apparatus **200** will be described.

As shown in FIG. **6**, the image forming apparatus **200** includes, as a control unit, a CPU **201**, a ROM **202**, a RAM **203**, an engine interface **204**, a sensor control unit **205**, a printing control unit **206**, a sheet conveyance unit **207**, an image processing interface **208**, a data control unit **209** and an operation unit interface **210**. Also, the image forming apparatus **200** includes, as an input unit and an output unit, an operation key **211** and an operation panel **212**.

The CPU (Central Processing Unit) **201** is used as a central processing unit of the image forming apparatus **200**. The CPU **201** provides various functions by reading and executing an OS or programs from a memory device (e.g., a ROM that will be described later). Also, the CPU **201** performs logical calculations, etc., using control programs stored in the ROM **202** and performs the controlling of each of the units, the calculating and editing of data, etc.

The ROM (Read Only Memory) **202** stores control programs, operational conditions, etc. Note that the image forming apparatus **200** may use, other than the ROM, a device or a medium that can store data (e.g., a USB memory, a SD card memory, a DVD-ROM, a CD-ROM).

The RAM (Random Access Memory) **203** is a work memory (cache memory) in which data necessary at the execution of program is stored temporarily. The RAM **203** is used as a work area in the case where the CPU **201** performs

logical calculations, etc. The RAM **203** performs read and write operations of variable data used for logical calculations of the control programs.

The engine interface **204** performs interface processes of control units that will be described later. The engine interface **204** is connected to the sensor control unit **205**, the printing control unit **206** and the sheet conveyance unit **207**.

The sensor control unit **205** controls operations of various types of sensors. The sensor control unit **205** is connected to a conveyance sensor or an encoder sensor, etc. Also, the sensor control unit **205** performs the inputting and the digitization of sensor information of the connected conveyance sensor or the encoder sensor, etc. The printing control unit **206** controls operations of the image forming unit **60**. The sheet conveyance unit **207** controls operations of the paper feeding roller (roller pair **21***c*) in FIG. **2** and the resist roller (**21***a*) in FIG. **2**.

The image processing interface **208** performs interface processes of the data control unit **209**. The data control unit **209** performs the writing and the reading of printing data and image quality data, that are read as digital data, to and from the memory device such as a hard disk, etc.

The operation unit interface **210** performs interface processes of the input unit and the output unit (e.g., operation key **211** and operation panel **212**). The operation key **211** is a key for the input operation by an operator (user). The operation panel **212** displays a status report or a setting status report of the image forming apparatus **200** using a display unit (e.g., a LCD or a LED device).

Recording Medium Conveyance Operations of the Image Forming Apparatus

Because operations of the image forming apparatus **200** for conveying the recording medium MR is basically the same as the ones of the conveyance apparatus **100**, the description of the operations is omitted.

According to the image forming apparatus **200** of the second embodiment described above, in the conveyance of the recording medium MR, the same effects as the conveyance apparatus **100** can be obtained.

Embodiments of the recording medium conveyance apparatus and the image forming apparatus have been described.

Further, the present invention is not limited to these embodiments, but various variations and modifications may be made without departing from the scope of the present invention.

The present application is based on and claims the benefit of priority of Japanese Priority Application No. 2012-240240 filed on Oct. 31, 2012 with the Japanese Patent Office, the entire contents of which are hereby incorporated by reference.

What is claimed is:

1. A recording medium conveyance apparatus for conveying a recording medium rolled around a roll pipe, the recording medium conveyance apparatus comprising:

a driving unit configured to drive the roll pipe;

a detection unit configured to detect a rotational operation of the roll pipe;

a conveyance unit configured to convey the recording medium and settable to fix the recording medium pulled out from the roll pipe by nipping the recording medium with at least two rollers;

a determination unit configured to determine that the recording medium is not fixed to the roll pipe when the detection unit detects more than a number of rotations, and to determine that the recording medium is fixed to the roll pipe when the detection unit does not detect more than said number of rotations, when the recording unit is fixed by the at least two rollers and the driving unit drives the roll pipe in a direction for rewinding the recording medium.

2. The recording medium conveyance apparatus as claimed in claim **1**, wherein the driving unit includes a clutch member for transmitting power to the roll pipe, and the clutch member transmits the power in a case where the roll pipe can be driven with a power equal to or less than a predefined amount of power and does not transmit the power in a case where the roll pipe cannot be driven with a power equal to or less than the predefined amount of power.

3. The recording medium conveyance apparatus as claimed in claim **1**, wherein the detection unit, in a case where the recording medium is fixedly held by the rollers, detects the rotational operation of the roll pipe when the driving unit reversely rotates the roll pipe to restore the recording medium.

4. The recording medium conveyance apparatus as claimed in claim **1**, wherein the detection unit detects the rotational operation of the roll pipe after a predefined period of time after the driving unit starts driving the roll pipe for rolling back the recording medium on the roll pipe.

5. The recording medium conveyance apparatus as claimed in claim **1**, wherein the determination unit, when a number of rotations of the roll pipe is less than a predefined number of rotations in the rotational operation of the roll pipe detected by the detection unit, determines that the recording medium is fixed to the roll pipe.

6. The recording medium conveyance apparatus as claimed in claim **4**, further comprising:

an input unit configured to input the predefined period of time.

7. The recording medium conveyance apparatus as claimed in claim **1**, wherein the feeding unit, in a case where the determination unit determines that the recording medium is fixed to the roll pipe, causes a speed of restoring the recording medium by rotating the roll pipe by the driving unit to be greater than a speed of conveying the recording medium by rotating the rollers by the conveyance unit.

8. The recording medium conveyance apparatus as claimed in claim **1**, wherein the conveyance unit, in a case where the determination unit determines that the recording medium is not fixed to the roll pipe, causes a speed of conveying the recording medium by rotating the rollers by the conveyance unit to be greater than a speed of restoring the recording medium by rotating the roll pipe by the driving unit.

9. The recording medium conveyance apparatus as claimed in claim **1**, wherein the conveyance unit discharges the recording medium by rotating the rollers in a forward direction in response to a determination that the recording medium is not fixed to the roll pipe.

10. The recording medium conveyance apparatus as claimed in claim **1**, further comprising:

an output unit configured to output a conveyance result of the recording medium as the conveyance unit rotates the rollers in a forward direction to discharge the recording medium.

11. An image forming apparatus including the recording medium conveyance apparatus as claimed in claim **1** and an image forming unit configured to form images on the recording medium.

12. A recording medium conveyance method comprising:

driving a roll pipe having a recording medium rolled thereon;

detecting a rotational state of the roll pipe;

nipping the recording medium with at least two rollers to convey the recording medium pulled out from the roll pipe;

determining that the recording medium is not fixed to the roll pipe when more than a number of rotations is detected and determining that the recording medium is fixed to the roll pipe when more than said number of rotations is not detected while the recording medium is held in a fixed position by the at least two rollers and the roll pipe is driven in a direction for rewinding the recording medium on the roll pipe.

13. A non-transitory computer readable recording medium in which a program for causing a computer to execute the recording medium conveyance method as claimed in claim **12** is recorded.

14. The recording medium conveyance apparatus as claimed in claim **5**, further comprising:

an input unit configured to input the predefined number of rotations.

* * * * *